

Reducing Mineral N Fertilizer Partially In Thompson Seedless Vineyards By Using Fulvic Acid And Effective Microorganisms

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Abstract: This study was initiated during 2013 and 2014 seasons as an attempt for replacing mineral N fertilizer partially in Thompson seedless vineyards by using fulvic acid and Effective microorganisms (EM). Mineral N fertilizer was applied at 25 to 100% of the suitable N (80 g / vine/ year). Both fulvic acid and EM were applied once at 10 to 25 ml / vine/ year. Using the suitable N via mineral N at 60 to 75% of the suitable N with fulvic acid and EM each at 10 to 15 ml was very effective in improving the yield comparing with using N completely via mineral N or when mineral N was applied at percentages lower than 60%. The promotion on vine nutritional status and quality was associated with reducing mineral N fertilizer percentages from 100 to 25% of N and at the same time increasing the levels of both fulvic acid and EM from 10 to 25 ml/ vine/ year. Supplying Thompson seedless grapevines with N (80 g / vine / year) through 60% mineral N fertilizer + fulvic acid and EM each at 15 ml / vine / year was suggested to be beneficial for promoting yield and fruit quality.

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1. Introduction

Recently, many attempts were made for overcoming yield poor in most grapevine cvs especially Thompson seedless by controlling the uptake of N as well as enhancing its availability at longer times by using organic and biofertilization.

The merits of organic and biofertilization on enhancing soil fertility and the availability of all nutrients surely reflected on improving yield (Cook, 1966 and Kannaiyan, 2002).

Previous studies showed that using all sources of N (mineral, organic and bio sources) was measurably preferable than using mineral N alone in improving the yield and quality of the berries in various grapevine cvs. (Abd El- Ghafar – Gehan (2002); Ahmed *et al.* (2003); Abd El- Hady (2003); Shawky *et al.* (2004); El- Shenawy and Stino (2005); Mahran (2005); Ibrahim – Asmaa (2006); El- Salhy *et al.* (2006); El- Khafagy (2006); Ahmed – Ebtsam (2007); Masoud, (2008); Ahmed *et al.* (2008); Madian (2010); Refaai (2011); Ahmed *et al.* (2011) and El- Khafagy, 2013).

This study was designed to throw some lights on the effect of using EM and the humic substance namely fulvic acid as a partial replacement for inorganic N fertilizer on growth, vine nutritional status, yield and quality of the berries of Thompson seedless grapevines. Selecting the best combined treatment that responsible for producing an economical yield was also considered.

2. Material and Methods

This study was carried out during 2013 and 2014 seasons on forty– five uniform in vigour 11 - years old Thompson seedless grapevines grown in Seds Experimental Station located at Seds village, Beni Suef Governorate where the texture of the soil is clay, well drained and water table not less than two meters deep (Table 1) Analysis of the soil was done according to Chapman and Pratt (1987) and Black *et al.* (1965). All the selected vines are planted at 2 x 2 m apart. The chosen vines (54 vines) were pruned during the first week of January in both seasons using head pruning method. Vine load was 72 eyes for all the selected vines on the basis of 15 fruiting spurs x 4 eyes plus 6 replacement spurs X two eyes. Surface irrigation system was followed using Nile water containing 160 ppm EC.

Except those dealing with the present treatments (application of antioxidants via foliage), all the selected vines (72 vines) received the usual horticultural practices which are commonly used in the vineyard.

This study included the following nine treatments from inorganic, fulvic acid and EM:

1. Application of the suitable N (80 g N/ vine) via 100 % inorganic N (240 g ammonium nitrate / vine / year) alone.
2. Application of the suitable N via 75 % inorganic N (180 g ammonium nitrate / vine / year) alone.
3. Application of the suitable N via 75 % + fulvic acid and each at 10 ml/ vine/ year.
4. Application of the suitable N via 60 % inorganic N (144 g ammonium nitrate / vine / year) alone.

5. Application of the suitable N via 60 % inorganic N + fulvic acid and EM each at 15 ml / vine/ year.
6. Application of the suitable N via 45 % inorganic N (108 g ammonium nitrate / vine / year) alone.
7. Application of the suitable N via 45 % inorganic N + fulvic acid and EM each at 20 ml / vine/ year.
8. Application of the suitable N via 30 % inorganic N (72 g ammonium nitrate / vine/ year) alone
9. Application of the suitable N via 30 % inorganic N + fulvic acid and EM each at 25 ml / vine/ year.

Each treatment was replicated three times, two vines, per each. Ammonium nitrate (33.5 % N) as a source of inorganic N was divided into three unequal batches as 45% at growth start (2nd week of April) and 20% after harvesting (1st week of August). Both fulvic acid and EM (1 ml contains 10⁷ cells) were added once before growth start (1st week of Mar.) Fulvic acid was added in the form of pure fulvic acid (100 % fulvic acid).

Table (1): Analysis of the tested soil:

Constituents	Values
Particle size distribution:	
Sand %	10.0
Silt %	21.5
Clay %	68.5
Texture	Clay
pH(1:2.5 extract)	8.05
EC (1:2.5 extract) (dsm ⁻¹) 1 cm / 25°C.	1.03
O.M. %	1.88
CaCO ₃ %	2.55
Total N %	0.10
Available P (Olsen, ppm)	2.22
Available K (ammonium acetate, ppm)	400

During both seasons, the following characters were measured, some vegetative growth characters namely main shoot length (cm.), number of leaves/ shoot and leaf area (cm²) (Ahmed and Morsy, 1999), chlorophylls a & b and total chlorophylls (mg/ 100 g F.W.) (Fadl and Seri El- Deen, 1978), percentages of N, P and K (Chapman and Pratt, 1987), berry setting %, yield expressed in number of clusters/ vine and yield / vine (kg.), cluster weight and dimensions (length & width), berry weight (g.) and dimensions (longitudinal & equatorial in cm) T.S.S. %, reducing sugars and total acidity % (e.g. tartaric acid / 100 ml juice) (A.O.A.C., 2000).

Statistical analysis was done using new L.S.D. test at 5% (Mead *et al.*, 1995).

3. Results

1- Some vegetative growth characters:

It is clear from the obtained data in Table (2) that the three growth characters namely main shoot length, number of leaves / shoot and leaf area were significantly affected with the nine nitrogen management. Under unorganic and biofertilization conditions, increasing the percentages of inorganic N from 30 to 100% of the suitable N caused a gradual stimulation on these growth characters. Generally speaking, using the suitable N via inorganic N at 30 to 75% besides organic and biofertilization with fulvic acid and EM (effective microorganisms) each at 10 to 20 ml / vine / year significantly stimulated all growth characters rather than using N as inorganic N at 30 to 75% alone. The promotion was significantly associated with reducing percentages of inorganic N from 75 to 60% and at the same time increasing levels of both fulvic acid and EM from 10 to 15 ml/ vine. Using the suitable N via 30 to 45% inorganic N under organic and biofertilization with fulvic acid and EM each at 20 to 25 ml/ vine significantly reduced these growth characters comparing with using inorganic N at 60 to 75 plus using organic and biofertilization. The minimum values of main shoot length (95.3 and 96.6 cm), number of leaves / shoot (25.0 & 26.1 leaf) and leaf area (106.0 & 104.1 cm²) were recorded on the vines that fertilized with N as 30% inorganic N alone. Fertilizing, Thompson seedless grapevines with N as 60% inorganic plus application of fulvic acid and EM each at 15 ml/ vine/ year gave the maximum values of main shoot length (124.3 & 125.6 cm), number of leaves/ shoot (35.7 & 38.0 leaf) and leaf area (124.3 & 125.4 cm²). These results were true during both seasons.

2- Plant pigments

It is obvious from the obtained data in Table (3) that under unorganic and bio fertilization with fulvic acid and EM conditions, increasing the percentages of inorganic N from 30 to 100 % caused a gradual promotion on chlorophylls a& b and total chlorophylls. Significant difference were observed between all percentages of inorganic N except between the higher two concentrations namely 75 and 100%. There was a gradual and significant promotion on these plant pigments with reducing the percentages of inorganic N from 100 to 30 % and at the same times increasing the levels of both fulvic acid and EM each from 10 to 25 ml/ vine/ year. Generally, these plant pigments were significantly increased with using inorganic N in combined with fulvic acid and EM over the application of inorganic N alone. The maximum values of chlorophyll a (29.9 & 30.6 mg/

100 g F.W.) and chlorophyll b (15.2 & 15.6) and total chlorophylls (45.1 & 46.2 mg/ 100 g F.W.) were observed on the vines that fertilized with N as 30% inorganic + fulvic acid and EM each at 25 ml / vine/ year. The lowest values of chlorophyll a, chlorophyll b and total chlorophylls were obtained owing to supplying the vines with N as 30% inorganic N alone. Similar results were revealed during 2013 & 2014 seasons.

3- Percentages of N, P and K in the leaves.

Data in the in Table (4) clearly show that increasing the percentages of inorganic N from 30 to 100% without organic and biofertilization caused a gradual stimulation on the percentage of N and a reduction on both P and K in the leaves. However, the effect either in increase or decrease was meaningless with increasing the percentages of inorganic N from 75 to 100%. Inorganic N at 30 to 75 when combined with both fulvic acid and EM each at 10 to 25 ml/ vine / year significantly was accompanied with enhancing the percentages of N, P and K when compared with using N as inorganic N alone. The promotion on these nutrients was significantly correlated with reducing percentages of inorganic N from 75 to 30% and increasing both fulvic acid and EM levels from 10 to 25 ml / vine/ year. The highest values of N (2.40 & 2.45 %), P (0.43 & 0.45 %) and K (1.97 & 2.01 %) were recorded on the vines that fertilized with N as 30% inorganic + 25 ml/ vine / year from both fulvic acid and EM. The minimum values of N (1.61 & 1.66 %) was presented in the vines that fertilized with N as 30% inorganic N alone. Using N completely via inorganic N (100% inorganic N) gave the lowest P (0.21 & 0.26%) and K (1.30 & 1.33). The maximum values of N (2.40 & 2.45 %), P (0.43 & 0.45%) and K (1.97 & 2.01 %) were obtained on the vines that fertilized with N as 30% inorganic besides fulvic acid and EM each at 25 ml/ vine / year. These results were true during both seasons.

4- Percentage of berry setting and yield/ vine:

It is evident from the obtained data in Table (5) that increasing the percentages of inorganic N from 30 to 100% significantly caused a gradual promotion on the percentage of berry setting, number of clusters / vine and yield per vine under unorganic and biofertilization conditions. Combined application of N via inorganic N at 30 to 75 % plus organic and biofertilization with fulvic acid and EM each at 10 to 25 ml/ vine/ year significantly was followed by promoting the percentage of berry setting and yield over the application of N via inorganic N at 30 to 75% alone. There was a gradual and significant promotion on the percentage of berry setting and yield / vine with reducing percentages of inorganic N from 75 to 60% and at the June time increasing levels of fulvic acid and EM from 10 to 15 ml/ vine / year. Using the

suitable N through 60 to 75% inorganic plus application of fulvic acid and EM each at 10% to 15 ml/ vine / year was significantly accompanied with enhancing the percentage of berry setting and yield/ vine comparing with using N as 30 to 45% inorganic + fulvic acid and EM each at 2 to 25 ml/ vine / year and EM each at 20 to 25 ml / vine/ year. A great and significant reduction on the percentage of berry setting and yield/ vine was observed with using inorganic N at percentages from 30 to 45% with or without organic and biofertilization compared with using N as organic N fertilizer at 60 to 75% with or without using organic and biofertilization. The best values of berry setting % (20.8 and 21.5%), number f clusters / vine (21.7 and 31.9 clusters/ vine) and yield (9.1 & 13.5 kg/ vine) were obtained on the vines that fertilized with the suitable as 60% inorganic N + fulvic acid and EM each at 15 ml / vine / year. The lowest values of berry setting (15.0 & 15.7 %), number of clusters (20.0 & 21.0 cluster / vine) and yield (5.9 & 6.2 kg/vine) during both seasons, respectively were presented on the vines that fertilized with N as 30% inorganic N alone. The vines fertilized with N completely via inorganic N from (the control vines) produced 7.3 & 9.2 kg during both seasons, respectively. The percentage of increase on the yield due to using the previous promised treatment over the control treatment reached 27.7 and 26.7 % during both seasons, respectively. The presented N management treatments failed to show significant effect on the number of clusters in the first season. Similar observations were noticed during both seasons.

5- Weight and dimensions (length & width) of cluster:

It can be stated from the obtained data in Table (6) that increasing percentages of inorganic N from 30 to 100% had a gradual promotion on cluster weight and dimensions (length & width). Significant differences on cluster characters were observed among all percentages except among the higher two percentages namely 75 and 100%. Using all sources of N (inorganic, fulvic acid and EM) was significantly favourable than using N via inorganic N alone in enhancing cluster characters. The promotion on weight and dimensions of cluster was significantly depended on reducing percentages of inorganic N from 75 to 60% and at the same time increasing levels of both fulvic acid and EM from 10 to 15 ml/ vine/ year. Under organic and biofertilization conditions, using inorganic N at percentages from 30 to 45% significantly reduced cluster characters comparing to using inorganic N at percentages ranged from 60 to 75% with organic and biofertilization with fulvic acid and EM each at 10-15 ml / vine/ year. The maximum weight (420.0 & 421.7 kg), length (26.6 & 26.9 cm) and width (14.0 & 14.3 cm) of cluster were recorded

on the vines that received N as 60% inorganic N plus both fulvic acid and EM each at 15 ml/ vine/ year. The lowest values were recorded on the vines that fertilized with N via 30 % inorganic N alone. Similar results were announced during both seasons.

6-Physical and chemical characteristics of the berries:

Varying N management treatments significantly altered both physical and chemical characteristics of the grapes. Under unorganic and biofertilization conditions, increasing the percentages of inorganic N percentages from, 30 to 100 % caused a progressive promotion on quality of the berries in terms of increasing berry weight and dimensions (longitudinal & equatorial), T.S.S. % and reducing sugars % and reducing total acidity %. No significant promotion on fruit quality was observed among the

higher two percentages (75 & 100%). As a general using, inorganic N at 30 to 75 % along with both fulvic acid and EM each at 10 to 25 ml/ vine/ tree was significantly preferable than using inorganic N fertilization alone in improving quality of the berries. There was a significant promotion on quality of the berries with reducing percentages of inorganic N from 75 to 30% and at the same time increasing levels of fulvic acid and EM from 10 to 25 ml/ vine/ year. The best results with regard to fruit quality of Thompson seedless grapevines were recorded on the vines that received N as 30% inorganic N + both fulvic acid and EM each at 25 ml/ vine / year. Unfavourable effects on fruit quality were observed on the vines that fertilized with N at 30%. These results were true during both seasons (Tables 7 & 8).

Table (2): Effect of inorganic N as well as application of Fulvic acid and EM as a partial replacement of inorganic N on some vegetative growth characters of Thompson seedless grapevines during 2013 & 2014 seasons.

Inorganic N, Fulvic acid and EM treatments	Main shoot length (cm)		No. of leaves/main shoot		Leaf area (cm ²)	
	2013	2014	2013	2014	2013	2014
N as 100 % Inorg. N alone	105.7	107.0	30.0	31.2	113.9	115.0
N as 75% Inorg. alone	103.3	104.6	28.7	29.9	111.3	112.4
N as 75 Inorg. + 10 ml Fulvic + 10 ml EM	119.5	120.8	34.6	35.7	120.0	121.1
N as 60 % Inorg. alone	101.6	102.9	27.2	28.3	109.0	110.1
N as 60 Inorg. + 15 ml Fulvic + 15 ml EM	124.3	125.6	35.7	38.0	124.3	125.4
N as 45 % Inorg. N alone	98.3	99.6	26.1	27.2	107.3	108.4
N as 45 Inorg. + 20 ml Fulvic + 20 ml EM	111.7	113.0	33.0	24.1	118.2	119.3
N as 30 % Inorg. N alone	95.3	96.6	25.0	26.1	106.0	107.1
N 30 Inorg. + 25 ml Fulvic + 25 ml EM	108.7	110.0	31.3	31.6	115.3	116.4
New L.S.D. at 5%	1.1	1.2	1.0	1.0	1.1	1.2

Inorganic = Inorg., EM = Effective microorganisms biofertilizer.

Table (3): Effect of inorganic N as well as application of fulvic acid and EM as a partial replacement of inorganic N on chlorophylls a & b and total chlorophylls (mg/ 100 g F,W.) in the leaves of Thompson seedless grapevines during 2013 & 2014 seasons.

Inorganic N, Fulvic acid and EM treatments	Chlorophyll a (mg/100 g FW)		Chlorophyll b (mg/100 g FW)		Total chlorophylls (mg/100 g FW)	
	2013	2014	2013	2014	2013	2014
N as 100 % Inorg. N alone	22.4	23.0	9.6	10.0	32.0	33.0
N as 75% Inorg. alone	22.0	22.7	9.5	9.9	31.5	32.6
N as 75 Inorg + 10 ml Fulvic + 10 ml EM	24.3	25.6	10.9	11.3	35.2	36.9
N as 60 % Inorg alone	20.0	20.6	8.4	8.9	28.4	29.5
N as 60 Inorg + 15 ml Fulvic + 15 ml EM	25.9	26.6	12.3	12.7	38.2	39.3
N as 45 % Inorg N alone	17.1	17.8	7.2	7.6	24.3	25.4
N as 45 Inorg + 20 ml Fulvic + 20 ml EM	28.0	28.6	13.4	14.0	41.4	42.6
N as 30 % Inorg N alone	15.1	15.7	6.1	6.5	21.2	22.2
N 30 Inorg + 25 ml Fulvic + 25 ml EM	29.9	30.6	15.2	15.6	45.1	46.2
New L.S.D. at 5%	1.4	1.5	0.9	1.0	1.0	1.0

Inorganic = Inorg., EM = Effective microorganisms biofertilizer.

Table (4): Effect of inorganic N as well as application of fulvic acid and EM as a partial replacement of inorganic N on the percentages of N, P and K in the leaves of Thompson seedless grapevines during 2013 & 2014 seasons.

Inorganic N, Fulvic acid and EM treatments	Leaf N %		Leaf P %		Leaf K %	
	2013	2014	2013	2014	2013	2014
N as 100 % Inorg. N alone	1.94	1.99	0.21	0.26	1.30	1.33
N as 75% Inorg. alone	1.92	1.97	0.22	0.27	1.311	1.34
N as 75 Inorg. + 10 ml Fulvic + 10 ml EM	2.05	2.10	0.37	0.40	1.68	1.71
N as 60 % Inorg. alone	1.82	2.87	0.27	0.31	1.41	1.43
N as 60 Inorg. + 15 ml Fulvic + 15 ml EM	2.17	2.22	0.40	0.42	1.75	1.78
N as 45 % Inorg. N alone	1.71	1.76	0.30	0.35	1.51	1.55
N as 45 Inorg. + 20 ml Fulvic + 20 ml EM	2.27	2.32	0.43	0.44	1.89	1.93
N as 30 % Inorg. N alone	1.61	1.66	0.34	0.37	1.60	1.64
N as 30 Inorg. + 25 ml Fulvic + 25 ml EM	2.40	2.45	0.43	0.45	1.97	2.01
New L.S.D. at 5%	0.05	0.06	0.02	0.03	0.8	0.7

Inorganic = Inorg., EM = Effective microorganisms biofertilizer.

Table (5): Effect of inorganic N as well as application of fulvic acid and EM as a partial replacement of inorganic N on the percentage of berry setting, number of cluster per vine and yield / vine of Thompson seedless grapevines during 2013 & 2014 seasons.

Inorganic N, Fulvic acid and EM treatments	Berry setting %		No. of clusters per vine		Yield/ vine (kg.)	
	2013	2014	2013	2014	2013	2014
N as 100 % Inorg. N alone	17.4	18.1	21.0	26.7	7.3	9.2
N as 75% Inorg. alone	17.3	18.0	21.0	26.6	7.3	9.2
N as 75 Inorg. + 10 ml Fulvic + 10 ml EM	19.7	20.4	21.6	29.9	8.7	12.0
N as 60 % Inorg. alone	16.7	17.4	20.6	25.0	6.8	8.3
N as 60 Inorg. + 15 ml Fulvic + 15 ml EM	20.8	21.5	21.7	31.9	9.1	13.5
N as 45 % Inorg. N alone	15.7	16.3	20.3	23.0	6.3	7.2
N as 45 Inorg. + 20 ml Fulvic + 20 ml EM	18.8	19.5	21.5	28.0	8.2	10.7
N as 30 % Inorg. N alone	15.0	15.7	20.0	21.0	5.9	6.2
N as 30 Inorg. + 25 ml Fulvic + 25 ml EM	18.1	18.8	21.4	27.0	7.8	9.9
New L.S.D. at 5%	0.5	0.6	NS	1.6	0.4	0.5

Inorganic = Inorg, EM = Effective microorganisms biofertilizer.

Table (6): Effect of inorganic N as well as application of fulvic acid and EM as a partial replacement of inorganic N on cluster weight and dimensions (length & width) of Thompson seedless grapevines during 2013 & 2014 seasons.

Inorganic N, Fulvic acid and EM treatments	Av. Cluster weight (g.)		Av. Cluster length (cm.)		Av. Cluster width (cm.)	
	2013	2014	2013	2014	2013	2014
N as 100 % Inorg. N alone	347.6	349.0	23.8	24.1	11.8	12.1
N as 75% Inorg. alone	346.0	347.3	23.7	24.0	1.7	12.0
N as 75 Inorg. + 10 ml Fulvic + 10 ml EM	400.6	402.0	25.5	25.8	13.1	13.4
N as 60 % Inorg. alone	329.0	330.6	22.9	23.2	11.3	11.6
N as 60 Inorg. + 15 ml Fulvic + 15 ml EM	420.0	421.7	26.6	26.9	14.0	14.3
N as 45 % Inorg. N alone	312.0	313.9	21.8	22.1	10.8	11.1
N as 45 Inorg. + 20 ml Fulvic + 20 ml EM	382.0	383.4	24.7	25.0	12.7	13.0
N as 30 % Inorg. N alone	295.0	297.0	21.0	21.3	10.3	10.6
N as 30 Inorg. + 25 ml Fulvic + 25 ml EM	363.0	367.0	24.0	24.4	12.2	12.5
New L.S.D. at 5%	15.9	16.1	0.6	0.6	0.4	0.4

Inorganic = Inorg., EM = Effective microorganisms biofertilizer.

Table (7): Effect of inorganic N as well as application of fulvic acid and EM as a partial replacement of inorganic N on the berry weight and dimensions of Thompson seedless grapevines during 2013 & 2014 seasons.

Inorganic N, Fulvic acid and EM treatments	Av. Berry weight (g.)		Av. Berry longitudinal; 9cm.)		Av. Berry equatorial (cm.)	
	2013	2014	2013	2014	2013	2014
N as 100 % Inorg. N alone	2.11	2.15	1.91	1.95	1.64	1.67
N as 75% Inorg. alone	2.10	2.13	1.90	1.94	1.64	1.70
N as 75 Inorg. + 10 ml Fulvic + 10 ml EM	2.18	2.21	1.96	2.00	1.56	1.60
N as 60 % Inorg. alone	1.97	2.00	1.83	1.87	1.63	1.67
N as 60 Inorg. + 15 ml Fulvic + 15 ml EM	2.28	2.31	2.03	2.10	1.76	1.80
N as 45 % Inorg. N alone	1.88	2.41	1.77	1.81	1.47	1.50
N as 45 Inorg. + 20 ml Fulvic + 20 ml EM	2.374	2.40	2.10	2.16	1.80	1.83
N as 30 % Inorg. N alone	1.81	1.84	1.71	1.45	1.41	1.45
N as 30 Inorg. + 25 ml Fulvic + 25 ml EM	2.44	2.47	2.16	2.15	1.86	1.90
New L.S.D. at 5%	0.06	0.06	0.05	0.05	0.06	0.06

Inorganic = Inorg., EM = Effective microorganisms biofertilizer.

Table (8): Effect of inorganic N as well as application of fulvic acid and EM as a partial replacement of inorganic N on some chemical characteristics of the berries of Thompson seedless grapevines during 2013 & 2014 seasons.

Inorganic N, Fulvic acid and EM treatments	T.S.S. %		Reducing sugars %		Total acidity %	
	2013	2014	2013	2014	2013	2014
N as 100 % Inorg. N alone	19.0	18.7	16.0	15.8	0.720	0.728
N as 75% Inorg. alone	19.5	19.2	16.5	16.2	0.719	0.726
N as 75 Inorg. + 10 ml Fulvic + 10 ml EM	21.2	19.9	18.1	16.9	0.690	0.694
N as 60 % Inorg. alone	20.0	19.7	17.0	16.7	0.718	0.727
N as 60 Inorg. + 15 ml Fulvic + 15 ml EM	21.5	21.2	18.5	18.2	0.661	0.665
N as 45 % Inorg. N alone	20.6	20.3	17.6	17.6	0.717	0.722
N as 45 Inorg. + 20 ml Fulvic + 20 ml EM	21.8	21.5	18.8	18.5	0.640	0.645
N as 30 % Inorg. N alone	20.9	20.6	17.9	17.6	0.716	0.721
N as 30 Inorg. + 25 ml Fulvic + 25 ml EM	22.3	22.0	19.3	19.0	0.607	0.612
New L.S.D. at 5%	0.3	0.3	0.3	0.3	0.020	0.018

Inorganic = Inorg., EM = Effective microorganisms biofertilizer.

4. Discussion:

The positive merits of using organic (fulvic acid) and biofertilizer (EM) on growth, vine nutritional status, yield and quality of the berries might be attributed to the following reasons:

1-Organic and biofertilization effectively enhanced water retention, saving irrigation water, soil aggregation, soil cation exchange, availability of different nutrients, antioxidants, natural hormones such as IAA, GA₃ and cytokinins, soil fertility, vitamins B, N fixation, soil organic matter, root development and enzymes such as nitrogenase (Cook, 1966, Dahama, 1999 and David, 2002).

2- They are responsible for reducing soil pH, soil salinity, soil pathogens and release of most nutrients (Dalbo, 1992 and Davis and Ghabbour, 1998).

These results are in concordance with those obtained by Abd El- Ghafar – Gehan (2002); Ahmed *et al.* (2003); Abd El- Hady (2003); Shawky *et al.*,

(2004); El- Shenawy and Stino (2005); Mahran (2005); Ibrahim – Asmaa (2006); El- Salhy *et al.* (2006); El- Khafagy (2006); Ahmed – Ebtsam (2007); Masoud, (2008); Ahmed *et al.* (2008); Madian (2010); Refaai (2011); Ahmed *et al.* (2011) and El- Khafagy (2013).

The best results with regard to yield and fruit quality of Thompson seedless grapevines were obtained due to using the suitable N (80 g N/ vine/ year) via 60% mineral N + fulvic acid and EM each at 15 ml/ vine/ year.

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